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EXPERIMENTS IN RICE PRODUCTION IN SOUTHWESTERN LOUISIANA

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INTRODUCTION

The largest acreage of rice in the United States in one area is in southwestern Louisiana within the parishes of Acadia, Allen, Beauregard, Calcasieu, Cameron, Evangeline, Jefferson Davis, Lafayette, St. Landry, and Vermilion (fig. 1). In this section, rice was first grown in small patches by Acadian settlers for home use. These people selected for rice growing the low places on the prairies where water would accumulate after rains. The crop was sown by hand, cut with a sickle, and threshed with a flail. With no facilities for supplying water when needed by the crop, production was small and uncertain. The commercial production of rice could not be developed by these methods without an unlimited supply of cheap labor, such as exists in the rice-producing countries of the Orient. This kind of labor was not obtainable, and without it the development of the rice industry was dependent upon the use of machinery.

It was first demonstrated in Acadia Parish by settlers from the upper part of the Mississippi Valley that rice could be produced profitably on the prairie lands by the use of wheat-farming machinery if irrigation water could be cheaply obtained. The successful

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lifting of water by steam pumps from a bayou near Crowley in 1885 was the first step in developing the rice industry of southwestern Louisiana. The canal systems which were soon organized enlarged the possibilities and contributed greatly toward making rice the money crop of this section of the State.

In 1887 rice culture began to assume some importance in this part of Louisiana. In 1889 Louisiana became the leading rice-producing State, with a total area of 84,377 acres, of which 25,637 acres were located in the southwestern prairie region. As early as 1899 the rice area of this section had increased to 146,735 acres, and since

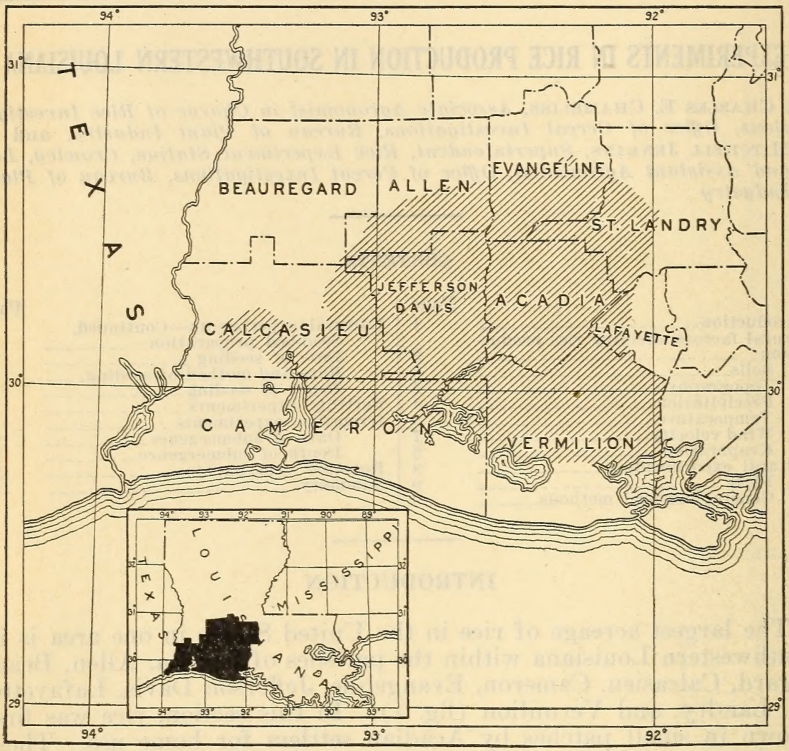

FIG. 1.—Outline map of southwestern Louisiana, showing the parishes in which rice was grown in 1923. The shaded portion of the map shows the distribution of the rice acreage within these parishes. Inset: Outline map of Louisiana, showing in black the rice-producing parishes of southwestern Louisiana

then this area has led all sections of the United States in the acreage and production of this crop.

The center of rice production in southwestern Louisiana has been Acadia Parish, the eastern part of Calcasieu, now known as Jefferson Davis Parish, and the northern and eastern parts of Vermilion Parish. In 1889 Acadia Parish had 15,352 acres of rice, Calcasieu Parish 8,655 acres, and Vermilion Parish 1,507 acres. The rice acreage of these parishes steadily increased during each succeeding decade, reaching the maximum in 1920. In this year there were in Acadia Parish 156,089 acres, Calcasieu Parish 90,060 acres, and Vermilion Parish 132,793 acres.

The acreage, acre yield, and production of rice in southwestern Louisiana from 1911 to 1923, inclusive, are compared in Table 1 with the acreage, acre yield, and production in Louisiana and in the United States for the same period.

TABLE 1.—*Acreage, acre yield, and production of rice in southwestern Louisiana,*[1] *in Louisiana,*[1] *and in the United States*[2] *during the 13-year period from 1911 to 1923, inclusive*

Year	Southwestern Louisiana			Louisiana			United States		
	Acreage	Production (bushels)		Acreage	Production (bushels)		Acreage	Production (bushels)	
		Per acre	Total		Per acre	Total		Per acre	Total
1911	271, 897	34. 7	9, 428, 319	359, 616	36. 4	13, 079, 706	696, 000	33. 0	22, 934, 000
1912	291, 094	33. 0	9, 600, 820	352, 549	36. 2	12, 773, 657	723, 000	34. 7	25, 054, 000
1913	333, 922	29. 4	9, 815, 902	400, 222	30. 6	12, 244, 008	827, 000	31. 1	25, 744, 000
1914	287, 215	33. 4	9, 588, 031	333, 824	35. 6	11, 872, 752	694, 000	34. 1	23, 649, 000
1915	336, 088	30. 7	10, 315, 750	397, 498	32. 7	12, 983, 796	803, 000	36. 1	28, 947, 000
1916	371, 766	42. 4	15, 753, 398	446, 571	43. 2	19, 297, 839	869, 000	47. 0	40, 861, 000
1917	429, 315	33. 5	14, 363, 218	506, 399	34. 7	17, 594, 823	981, 000	35. 4	34, 739, 000
1918	491, 893	32. 3	15, 903, 814	580, 920	33. 5	19, 484, 566	1, 119, 000	34. 5	38, 606, 000
1919	500, 669	34. 3	17, 183, 829	560, 724	34. 7	19, 481, 342	1, 063, 000	39. 5	41, 985, 000
1920	611, 036	32. 8	20, 063, 206	754, 081	34. 5	26, 052, 320	1, 336, 000	39. 0	52, 066, 000
1921	416, 162	35. 5	14, 780, 758	483, 644	36. 9	17, 838, 180	921, 000	40. 8	37, 612, 000
1922	483, 694	35. 0	16, 930, 386	557, 912	36. 8	20, 547, 349	1, 055, 000	39. 8	41, 965, 000
1923	426, 640	31. 4	13, 395, 089	473, 003	32. 4	15, 325, 367	892, 000	37. 2	33, 256, 000
Average	403, 953	33. 7	13, 624, 809	477, 459	35. 2	16, 813, 516	921, 462	37. 1	34, 416, 769

[1] Compiled from the records of the Louisiana State Rice Milling Co. (Inc.), Crowley, La.
[2] Compiled from the reports of the Bureau of Agricultural Economics, U. S. Department of Agriculture.

NATURAL FACTORS AFFECTING RICE PRODUCTION

Rice produces well in regions of high seasonal temperatures where its requirements for water can be supplied either directly or indirectly by precipitation. It grows on many types of soils, though the crop is usually more productive on clay than on soils of lighter texture. These natural factors, especially temperature and water, limit the extension of the rice area.

The important natural factors which have contributed to the successful development of rice culture in southwestern Louisiana are suitable soils underlain by an impervious subsoil, topography, precipitation, and temperature.

SOILS

There are several types of soils in this region which because of topography, texture, and character of subsoil are well adapted to the growing of rice. The most typical of these is the Crowley silt loam. This soil is the predominating type in Acadia Parish, with 244,160 acres of the total area of 407,168 acres. It also is found in other parishes of southwestern Louisiana and in the rice-producing section of Arkansas.

The Crowley silt loam ranges in depth from 10 to 25 inches, with an average depth of approximately 16 inches. It is a brown or ash-gray loam containing from 22.92 to 27.92 per cent of clay, 55.20 to 68.84 per cent of silt, 4.20 to 12.52 per cent of very fine sand, and 0.77 to 2.06 per cent of organic matter. There is a sufficient propor-

tion of clay in this soil to give it a loamy cohesiveness which may cause puddling when plowed in a wet condition. The subsoil is a mottled blue and yellow clay, very plastic and extremely impervious. There is no movement of water through this subsoil in situ. Wherever this clay is properly used in the construction of canal banks and field levees seepage is so small as to be negligible.

TOPOGRAPHY

The flatness of the surface of this area permits the application of irrigation water over large tracts with a limited number of field levees. It also permits the construction of low broad levees, which offer no barriers to the use of heavy machinery in the preparation of the soil and in harvesting the crop.

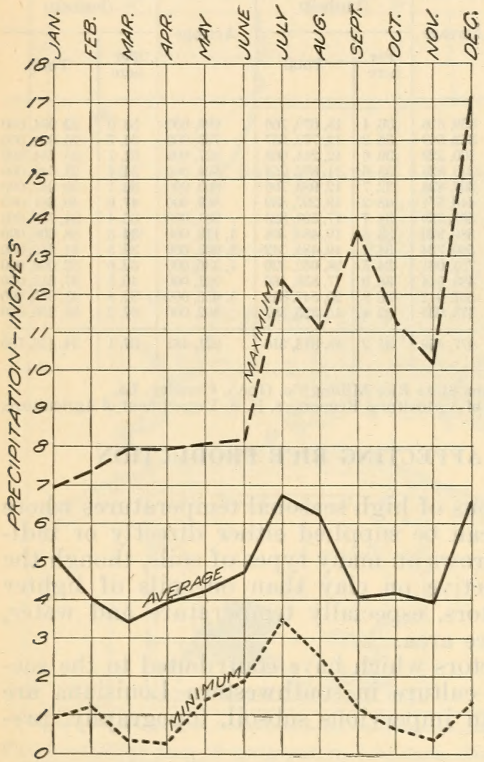

FIG. 2.—Diagram showing the maximum, minimum, and average rainfall at the Rice Experiment Station, Crowley, La., for each month during the 14-year period from 1910 to 1923, inclusive

Prairies that are comparatively level extend southward from approximately the central part of Calcasieu, Allen, and Evangeline Parishes to the marshes bordering the Gulf of Mexico. In the western part of St. Landry and Lafayette Parishes and the extreme eastern part of Vermilion Parish the prairies slope to the southwest. Within this area the altitude varies from a few feet to 47 feet above sea level. As a rule the slope is sufficient for good drainage by gravity, but not too great to prevent the holding of irrigation water on large tracts by low field levees.

PRECIPITATION

The quantity of water required for the irrigation of the rice crop is dependent upon the precipitation within the area under cultivation and upon the watershed of its streams. The average annual precipitation recorded at the Rice Experiment Station, Crowley, La., for the period from 1910 to 1922, inclusive, is 56.33 inches. For the same period of years Jennings, La., had an average annual rainfall of 56.60 inches; Lake Charles, La., 61.57 inches; and Lakeside, La., 64.51 inches. This precipitation as a source of supply is sufficient to meet the water requirements of the crop and is fairly well distributed throughout the year.

The average monthly precipitation of the months having the greatest rainfall at Crowley may be taken as representative of southwestern Louisiana, as the rainfall at this station differs but slightly from the precipitation at the other localities where records are kept. During the 14-year period from 1910 to 1923, inclusive, the average precipitation at Crowley, as shown in Table 2 and Figure 2, for January was 5.16 inches; June, 4.72 inches; July, 6.89 inches; August, 6.21 inches; and December, 6.60 inches. The largest precipitation during the growing season occurs in July and August, when the crop requires its maximum irrigation. Although the precipitation over this prairie section is heavy, plowing and seeding are seldom delayed, nor is there serious loss of grain at harvest, as the months in which these field operations are usually done are comparatively dry.

TABLE 2.—*Monthly, average monthly, annual, and average annual precipitation at the Rice Experiment Station, Crowley, La., for the 14-year period from 1910 to 1923, inclusive*

[Data in inches]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1910	4.04	3.05	1.26	1.59	7.61	8.18	9.76	3.60	3.83	1.90	2.42	4.30	51.54
1911	3.50	1.21	2.53	5.99	1.55	4.81	12.39	7.63	1.89	5.07	3.76	11.87	62.20
1912	6.99	4.64	4.24	4.50	4.03	5.99	6.68	5.59	1.63	1.55	.79	17.04	63.67
1913	5.63	2.78	2.60	4.66	4.01	3.47	4.67	8.55	13.67	5.49	2.09	3.74	61.36
1914	.96	5.01	7.13	5.59	2.28	2.48	7.28	3.48	1.78	3.09	6.92	3.68	49.68
1915	6.62	7.33	2.43	.28	4.51	3.49	5.38	11.07	1.14	2.64	2.15	5.44	52.48
1916	6.68	1.66	.34	2.46	4.90	1.93	7.70	9.82	2.69	1.81	.36	5.85	46.20
1917	4.05	3.52	3.67	2.53	1.38	5.63	8.85	2.51	2.29	.69	1.09	1.53	37.74
1918	6.10	2.95	3.44	7.91	1.50	3.98	4.74	6.01	3.75	10.36	6.64	4.48	61.86
1919	6.36	6.39	1.39	4.90	8.02	4.01	6.08	6.46	3.87	11.39	4.88	1.26	65.01
1920	6.97	5.37	1.62	3.28	4.43	4.52	10.56	9.10	3.66	5.17	4.15	9.18	68.01
1921	2.79	2.25	3.63	4.49	1.77	6.69	4.26	3.04	1.71	2.93	3.73	5.40	42.69
1922	6.38	5.17	6.31	1.58	5.59	3.86	4.62	6.29	7.28	2.98	10.23	9.60	69.89
1923	5.19	4.88	7.94	5.40	7.93	7.05	3.50	3.83	7.77	2.69	6.37	8.97	71.52
Average	5.16	4.01	3.47	3.94	4.25	4.72	6.89	6.21	4.07	4.13	3.97	6.60	57.42
Maximum	6.99	7.33	7.94	7.91	8.02	8.18	12.39	11.07	13.67	11.39	10.23	17.04	71.52
Minimum	.96	1.21	.34	.28	1.38	1.93	3.50	2.51	1.14	.69	.36	1.26	37.74

TEMPERATURE

Temperature, as well as rainfall, is an important factor in limiting the area of rice culture. The largest areas of rice production are located in regions having a mean temperature of 75° F. during a growing season of five months. The annual mean temperature of southwestern Louisiana is 68° F. The proximity of the Gulf of Mexico and the numerous streams and lakes in this part of the State seem to affect the temperature conditions to such an extent that excessive heat in summer and extreme cold in winter seldom occur. The range of the annual mean temperature within 100 miles of the coast is only 1 degree. Temperature data for the Rice Experiment Station at Crowley are given in Table 3 and are shown graphically in Figure 3.

TABLE 3.—*Mean, average mean, maximum, and minimum temperatures at the Rice Experiment Station, Crowley, La., for each month during the 14-year period from 1910 to 1923, inclusive*

[Data in degrees F.]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean:												
1910	55	54	61	66	74	78	81	82	79	68	60	53
1911	60	62	65	71	74	82	80	81	82	70	55	54
1912	47	49	58	70	75	77	82	81	80	71	56	53
1913	57	52	59	65	73	78	82	82	76	65	65	52
1914	54	51	56	68	74	83	83	81	77	68	62	49
1915	52	51	54	67	75	82	82	80	79	70	63	54
1916	59	55	63	65	75	80	81	81	76	68	59	57
1917	56	56	62	66	71	79	82	81	76	64	55	49
1918	44	60	67	66	74	83	82	81	73	72	58	56
1919	50	56	62	67	73	79	82	83	78	77	64	55
1920	56	59	64	68	77	79	81	81	80	66	55	51
1921	58	63	69	67	73	80	82	85	81	68	65	59
1922	53	60	60	71	76	81	82	82	78	68	63	62
1923	59	56	60	69	74	81	81	82	78	67	57	60
Average	54	56	61	68	74	80	82	82	78	69	60	55
Maximum:												
1910				87	91	92	93	94	93	91	83	80
1911	78	85	93	88	98	102	94	96	95	93	86	74
1912	75	74	81	88	93	93	97	95	97	91	82	78
1913	79	75	82	85	90	97	98	96	95	89	86	79
1914	78	77	80	86	92	100	97	94	94	89	85	72
1915	75		77	93	94	98	97	95	94	90	88	75
1916	78	79	85	85	94	96	95	94	94	90	85	84
1917	80	82	82	86	92	97	96	96	92	91	83	80
1918	74	79	85	85	91	100	96	96	93	92	80	80
1919	72	76	82	88	89	94	95	97	91	90	85	81
1920	80	75	81	89	91	95	94	92	95	87	82	72
1921	77	79	85	84	96	94	98	98	95	90	85	82
1922	79	79	81	86	92	97	95	101	92	90	86	83
1923	78	79	83	86	92	93	95	94	91	92	79	77
Minimum:												
1910				34	51	63	69	71	60	30	30	24
1911	18	25	40	49	50	65	65	67	67	37	22	27
1912	19	24	35	42	50	62	70	66	61	41	23	31
1913	28	27	31	40	54	53	70	67	48	36	33	22
1914	26	27	29	37	55	68	69	69	52	33	32	25
1915	27		25	32	56	64	62	63	58	41	28	27
1916	26	27	30	34	51	65	70	63	44	37	21	21
1917	27	23	27	40	43	55	70	63	54	28	26	17
1918	9	30	43	38	50	66	65	69	47	45	35	27
1919	22	33	38	42	50	57	71	63	56	58	34	27
1920	30	34	30	42	59	64	70	66	63	28	27	28
1921	34	34	40	39	43	67	69	67	68	35	37	31
1922	31	31	30	46	55	64	66	67	61	44	34	33
1923	34	29	27	42	48	66	68	67	60	35	33	32

TABLE 4.—*Dates of freezing temperatures, the last in spring and the first in fall, at the Rice Experiment Station, Crowley, La., for each year from 1910 to 1923, inclusive*

Year	Freezing temperature				Period free	Year	Freezing temperature				Period free
	Last in spring		First in autumn				Last in spring		First in autumn		
	Date	Temperature	Date	Temperature			Date	Temperature	Date	Temperature	
		°F.		°F.	Days			°F.		°F.	Days
1910			Oct. 28	30	300	1917	Mar. 6	27	Oct. 20	32	227
1911	Feb. 24	31	Nov. 12	28	260	1918	Feb. 5	32	Dec. 2	32	299
1912	Feb. 21	29	Nov. 3	29	255	1919	Jan. 13	32	Dec. 10	32	330
1913	Mar. 17	31	Dec. 8	28	265	1920	Mar. 7	32	Oct. 28	28	234
1914	Mar. 22	32	Nov. 19	32	241	1921			Dec. 5	31	338
1915	Apr. 4	32	Nov. 16	30	225	1922	Mar. 4	30			302
1916	Mar. 4	30	Nov. 15	28	255	1923	Mar. 20	27	Dec. 15	32	269

January and December are the coldest months, while June, July, and August are the hottest. For the 14-year period from 1910 to 1923, inclusive, the mean temperatures for these months at the Rice Experiment Station, which may be taken as the approximate temperatures for this prairie section, were 54°, 55°, 80°, 82°, and 82° F., respectively. During the same years the seasonal mean temperature from April 1 to October 31 was 75.9° F. The highest temperature recorded for this period was 102° F. in June, 1911, and the lowest was 9° F. in January, 1918. These extreme temperatures are rare. The latest freezing temperature in spring from 1910 to 1923, inclusive, was recorded on April 4, 1915, and the earliest freezing temperature in autumn was on October 20, 1917, as shown in Table 4. A period of approximately 300 days free from freezing temperatures is not uncommon.

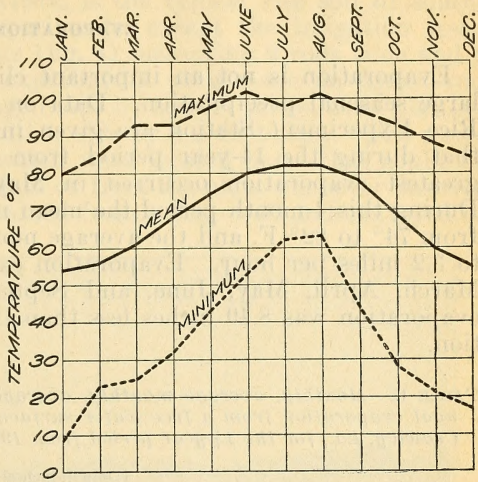

FIG. 3.—Diagram showing the maximum, minimum, and mean temperatures at the Rice Experiment Station, Crowley, La., for each month during the 14-year period from 1910 to 1923, inclusive

TABLE 5.—*Maximum, minimum, and average monthly wind velocity at the Rice Experiment Station, Crowley, La., for theh 14-year period from 1910 to 1923, inclusive*

[Data in miles per hour]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1910	4.8	5.0	4.3	4.5	3.7	2.9	2.3	1.8	1.7	2.9	3.2	4.2
1911	5.5	4.9	3.9	5.0	2.5	2.3	2.2	2.0	1.5	2.6	3.9	4.3
1912	4.1	5.0	4.7	4.1	2.8	4.0	1.8	2.1	2.4	3.2	2.7	4.2
1913	4.5	3.8	4.5	4.2	3.0	2.9	2.1	1.4	2.1	2.5	1.9	2.1
1914	3.4	4.2	3.6	4.0	3.5	2.2	2.2	1.8	2.2	2.7	2.8	3.9
1915	3.9	4.5	4.4	4 3	4.1	2.5	2.4	3.4	2.4	2.0	2.9	3.8
1916	5.3	4.2	5.3	3.9	3.1	2.9	2.0	1.5	1.6	2.4	3.9	4.4
1917	4.9	4.7	5.3	4.7	4.5	2.5	2.4	1.5	2.0	2.7	2.3	4.4
1918	5.4	5.4	3.6	4.0	3.7	2.0	1.2	1.6	1.9	1.7	2.6	1.9
1919	2.6	4.5	4.0	3.4	2.6	2.6	1.3	1.5	2.2	1.8	2.4	3.5
1920	4.3	3.5	5.5	5.2	2.6	2.1	1.8	1.2	1.7	2.3	2.1	4.0
1921	3.5	3.8	4.3	4.0	2.2	2.1	1.3	1.3	.9	2.1	3.4	3.0
1922	4.3	3.9	5.4	4.9	3.0	1.7	1.5	1.7	1.6	1.5	2.7	3.3
1923	3.2	4.6	5.1	4.0	3.3	2.3	2.1	1.9	1.3	3.0	2.5	4.0
Average	4.3	4.4	4.6	4.3	3.2	2.5	1.9	1.8	1.8	2.4	2.8	3.6
Maximum	5.5	5.4	5.5	5.2	4.5	4.0	2.4	3.4	2.4	3.2	3.9	4.4
Minimum	2.6	3.5	3.6	3.4	2.2	1.7	1.2	1.2	.9	1.5	1.9	1.9

WIND VELOCITY

Although this section is exposed to West Indian hurricanes, winds are seldom responsible for the lodging of rice. The maximum,

minimum, and average monthly wind velocity at the Rice Experiment Station, Crowley, La., for the 14-year period from 1910 to 1923, inclusive, is given in Table 5.

EVAPORATION

Evaporation is not an important climatic factor in a region of large seasonal precipitation. Data on evaporation recorded at the Rice Experiment Station are given in Table 6. These data show that during the 14-year period from 1910 to 1923, inclusive, the greatest evaporation occurred in May, June, July, and August. During this 4-month period the mean monthly temperatures ranged from 74° to 82° F. and the average monthly wind velocity from 1.8 to 3.2 miles per hour. Evaporation exceeded precipitation only in March, April, May, June, and September. The average annual evaporation was 8.49 inches less than the average annual precipitation.

TABLE 6.—*Monthly, average monthly, average daily, annual, and average annual evaporation from a free water surface at the Rice Experiment Station, Crowley, La., for the 14-year period from 1910 to 1923, inclusive*

[Data in inches]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1910	1.745	2.685	3.269	5.656	5.862	5.772	5.544	5.394	4.580	4.306	2.668	2.405	49.886
1911	1.406	2.892	3.951	5.824	5.310	6.887	5.552	5.417	4.139	4.388	3.102	2.882	51.750
1912	1.966	2.994	3.305	4.030	5.694	5.925	5.080	5.750	4.170	4.004	2.458	2.108	47.484
1913	1.551	2.603	3.010	5.065	5.973	5.716	5.424	5.344	3.777	4.093	2.249	1.947	46.752
1914	2.053	2.246	2.815	3.981	5.237	6.835	6.123	4.420	5.145	3.506	2.168	2.411	46.940
1915	1.306	2.425	3.489	4.668	5.953	5.839	6.609	5.972	4.876	3.883	3.240	2.019	50.279
1916	2.018	2.695	4.297	4.755	5.784	6.304	5.733	5.208	5.092	5.220	2.999	2.403	52.508
1917	1.662	2.560	3.893	4.919	6.533	7.651	6.022	5.647	4.835	4.516	2.480	2.306	53.024
1918	2.193	2.201	4.146	4.180	6.136	6.695	6.791	5.709	5.276	3.794	2.982	2.198	52.299
1919	1.483	2.552	3.293	4.827	5.423	4.587	5.245	5.409	5.105	3.754	2.932	2.098	46.708
1920	.964	2.226	2.959	3.174	5.052	4.946	4.388	5.522	5.253	3.097	2.252	1.884	41.717
1921	2.116	2.966	3.927	4.939	6.766	5.714	4.946	6.501	4.110	3.371	2.037	1.937	49.330
1922	2.598	2.351	3.726	4.838	5.911	5.305	5.610	5.832	4.652	4.649	2.963	2.875	51.310
1923	2.133	1.867	3.723	3.284	5.502	5.290	4.897	5.345	4.369	4.328	2.581	1.690	45.009
Average	1.800	2.519	3.557	4.581	5.795	5.962	5.569	5.534	4.670	4.065	2.651	2.226	48.928
Average daily	.058	.090	.115	.153	.187	.199	.180	.179	.156	.131	.088	.072	------
Maximum	2.598	2.994	4.297	5.824	6.766	6.887	6.791	6.501	5.276	5.220	3.240	2.882	------
Minimum	.964	1.867	2.815	3.174	5.052	4.587	4.388	4.420	3.777	3.097	2.037	1.690	------

CULTURAL EXPERIMENTS

The cultural treatment of the rice crop within the limits that have been defined determines its commercial value. This value is dependent largely upon yields, though the quality of the rice that is produced is also a factor.

Seed-bed preparation, seeding, soil fertility, irrigation, rotation, and weed control are the most important human factors affecting rice production. These factors are discussed in this bulletin. The cultural methods recommended are based on data obtained from experiments conducted at the Rice Experiment Station, Crowley, La., in cooperation with the Louisiana Agricultural Experiment Station during the 13-year period, 1911 to 1923, inclusive.

PLATS

The soil of the Rice Experiment Station farm is the Crowley silt loam, which, as stated elsewhere, is the typical rice soil of southwestern Louisiana. The experiments, except the irrigation tests, were made on tenth-acre plats (fig. 4) measuring 2 rods wide and 8 rods long. The irrigation experiments were made on square-rod plats. The plats were arranged side by side in series, each plat being separated from that on either side by a 5-foot alley. The series were inclosed by levees in which were located gates that could be operated to discharge water into or from the plats whenever desired. The irrigation water was obtained from a deep well and conveyed to

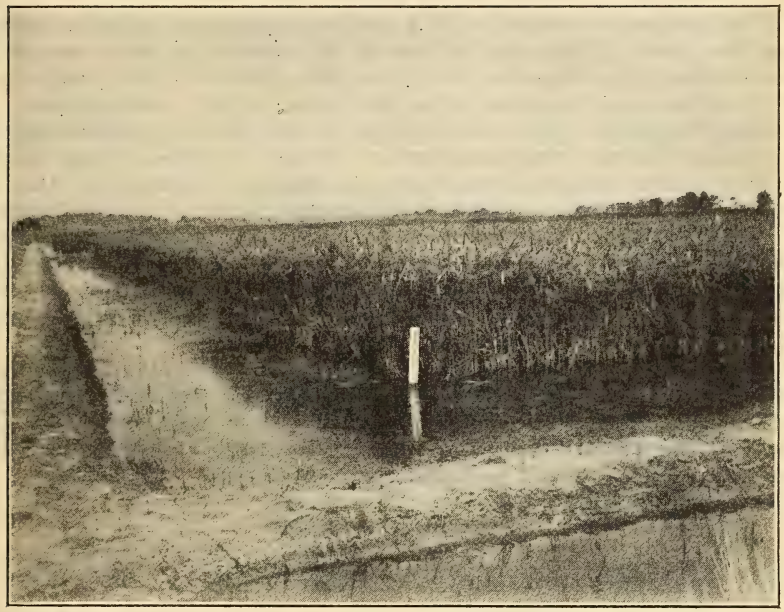

FIG. 4.—General view of plats at the Rice Experiment Station, Crowley, La., during submergence. The land is covered with approximately 6 inches of water

the series through ditches. These ditches also served for drainage purposes.

GENERAL CULTURAL METHODS

The land used in the experiments was cropped during the previous year to soybeans, except for fertilizer and irrigation experiments. The beans were sown in early June at the rate of 30 pounds per acre in rows 4 feet apart and were cultivated. The seed was harvested and the stems and leaves plowed under. The vegetable matter thus added to the soil greatly improved its physical condition, the frequent cultivations served to control weeds, especially red rice, and plant food in the form of nitrogen was added to the soil. No commercial fertilizers were applied to the plats except those used for the fertilizer experiments.

The land used in the experiments was plowed in late autumn or early winter to a depth of 5 to 7 inches except as the depth was varied in the depth-of-plowing experiments and was well drained during the winter. A smooth seed bed was obtained by dragging the plowed land in spring before double-disking it. It was then harrowed, after which a float was used upon it. After another double-disking the float was again used. The land was then harrowed and seed sown immediately. Harrowing after the float leaves the surface soil loose and finely divided to a depth of several inches and makes a seed bed which retains moisture so well that irrigation is seldom used to promote germination. A rough seed bed was prepared by dragging the plowed land in spring before disking and harrowing only once before the seed was sown.

The rice seed was sown with a drill to a depth of 2 inches during the first week of May at the rate of 80 pounds per acre, except in the seeding experiments. In these the manner, date, rate, and depth of seeding depended upon the factor under investigation.

The irrigation water was applied to the plats approximately 30 days after the rice plants emerged. At this time the average height of the plants ranged from 8 to 13 inches. Throughout the remainder of the growing season an average depth of approximately 6 inches of water was maintained. In the irrigation experiments, the time of application and depth of submergence varied according to the particular factor under investigation. Fresh water was admitted to the plats when needed to equal the losses from seepage, evaporation, and transpiration.

The plats were drained when the panicles were well turned down. The grain was harvested with a hand hook and put in large shocks, where it remained for several weeks before it was threshed. The shocks were strongly built to withstand the wind and so capped that the grain was protected from rain as well as sun.

SEED-BED PREPARATION

PLOWING

Plowing is the first tillage operation in the preparation of a seed bed for rice. It is important, for it provides a surface on which the necessary tillage prior to seeding can be satisfactorily done. The rice fields of southwestern Louisiana should be plowed in late autumn or early winter, the weather conditions of November being very favorable for field work on account of the comparatively small precipitation during this month. At this time plowing can be more thoroughly done and with less time and labor than in December and January, when the increasing number of rainy days necessarily interferes with effective work. The soil of early-plowed land that is well drained during the winter usually is well aerated. It pulverizes easily in spring and can be worked readily into condition for seeding. Winter-plowed land, however, must be kept free of surface water. Lack of winter drainage may necessitate a second plowing in the spring and require much labor to get even an average seed bed. Land that is plowed in spring must be disked and har-

rowed immediately. This tillage is necessary to retain the soil moisture, which evaporates rapidly under the action of the winds at this season of the year. Under normal weather conditions, more labor is required in preparing the Crowley silt loam when plowed in spring than when plowed in winter.

One object in plowing land for rice is to put the soil in such a condition that it may be easily prepared for conserving the needed moisture and heat for germination. Plowing in late autumn or early winter to a depth of 5 to 7 inches usually leaves the soil in a better physical condition for tillage. It also provides for a greater aeration of the soil and a greater feeding area for the rice plants than when the land is plowed to the depth of 2 to 3 inches. During a dry period following seeding there also is less loss of moisture on the land that is deeper prepared than on the shallow preparation. The deeper soil preparation insures a more thorough destruction of perennial weeds, better germination, a better stand, a stronger root growth, and a greater yield.

Data showing the results of an experiment on varying the depth of plowing are given in Table 7. In this experiment the seed was sown approximately May 1 on a smooth seed bed by a drill to the depth of 2 inches at the rate of 80 pounds per acre. These data show that in each year during the 4-year period from 1917 to 1920, inclusive, greater yields were obtained from the deeper than from the more shallow plowing. The average increase in yield from deeper plowing was 395 pounds of rice per acre.

TABLE 7.—*Annual and average yields of Wataribune rice obtained in the depth-of-plowing experiments at the Rice Experiment Station, Crowley, La., during the 4-year period from 1917 to 1920, inclusive*

Depth of plowing	Yields per acre (pounds)				
	1917	1918	1919	1920	Average
2 to 3 inches	1,600	2,500	1,200	1,380	1,670
5 to 7 inches	1,780	2,760	1,680	2,040	2,065

DISKING AND HARROWING

In southwestern Louisiana there is a tendency to grow the rice crop with a minimum of preparation. To determine the extent of preparation which may be required, an experiment including smooth and rough seed beds was conducted at the Rice Experiment Station.

A smooth seed bed was prepared by first dragging, in early spring, the land which had been plowed during the previous winter to a depth of 5 to 7 inches. Immediately after dragging, the land was double-disked and harrowed. Later it was dragged and double-disked a second time. Just before the seed was sown the land was dragged again and harrowed. A rough seed bed was prepared by giving one dragging, double-disking, and harrowing. In this experiment the seed was sown approximately May 1 with a drill to a depth of 2 inches at the rate of 80 pounds per acre. Data obtained in the seed-bed preparation experiment are given in Table 8.

TABLE 8.—*Annual and average yields of Wataribune rice obtained in the seed-bed preparation experiments at the Rice Experiment Station, Crowley, La., during the 4-year period from 1917 to 1920, inclusive*

Character of preparation (depth of plowing, 5 to 7 inches)	Yields per acre (pounds)				
	1917	1918	1919	1920	Average
Seed-bed surface:					
Rough	2,020	1,850	1,080	1,960	1,728
Smooth	1,780	2,760	1,680	2,600	2,205

The average increase of 477 pounds of rice per acre obtained on a smooth seed bed shows that a rough bed is not suited for the seeding of rice. A good stand of rice can not be obtained unless the seed is evenly distributed in the row and below the soil surface. To distribute seed at the proper distance in the row and at the desired depth, the soil must have a comparatively smooth surface and good tilth for at least 2 inches in depth. If the land has been carefully plowed, this soil condition can be obtained without much expense by the use of disk, harrow, and drag. Under unfavorable weather conditions soil in good tilth increases the chances of germination and quick growth of the young rice plants.

DATE OF SEEDING

In the date-of-seeding experiments the land was plowed in winter to a depth of 5 to 7 inches and the seed sown at different dates on a smooth seed bed with a drill to a depth of 2 inches at the rate of 80 pounds per acre. The average yields obtained in these experiments for periods of varying length in the 7-year period from 1917 to 1923, inclusive, which are given in Table 9, show that the best approximate date for sowing rice probably is May 14. The relatively light rainfall during the first three weeks in May insures good soil preparation and therefore better stands. These conditions usually are not obtainable in the last week of May and in June, on account of heavier precipitation.

TABLE. 9.—*Annual and average yields of Wataribune rice obtained in the date-of-seeding experiments at the Rice Experiment Station, Crowley, La., during periods of varying length in the seven years from 1917 to 1923, inclusive*

Average date of seeding	Yields per acre (pounds)										
	Annual							Average for years stated (dates inclusive)			
	1917	1918	1919	1920	1921	1922	1923	3 years, 1920 to 1922	4 years, 1919 to 1922	4 years, 1920 to 1923	5 years, 1917 and 1919 to 1922
Apr. 30		2,760		2,620	1,750	1,010	1,340	1,793		1,680	
May 14	1,780		3,080	2,710	2,100	1,660		2,157	2,387		2,266
May 28				2,550	2,400	1,870	1,250	2,273		2,017	
June 14	1,256		1,430	1,910	1,780	2,240	1,270	1,977	1,840	1,800	1,723

Weather conditions in southwestern Louisiana are too unsettled for the sowing of rice until the latter part of April. Prior to April 15 the mean temperature is too low to give the proper warmth to the soil for quick germination. Cold rains and winds, which are frequent at this time of the year, also make it difficult and often impossible to prepare a good seed bed. In addition, seed sown at too early a date may rot before germination. These conditions do not prevail after the last week in April or occur too seldom to cause serious loss.

The relation of mean temperature to date during the seeding season is shown in Table 10. The mean temperature for the week ended April 28 for the 14-year period from 1910 to 1923, inclusive, was 70° F. This temperature is several degrees higher than the mean temperature for each of the first two weeks of April. The weeks ended May 5 and 12 had mean temperatures of 71° and 72° F., respectively. The mean temperature for the last week of April and for each of the first two weeks of May is sufficiently high to insure good germination and stands, so far as the temperature factor is concerned. In addition, the weeks ended May 5 and 12, as shown in Table 10, have a relatively light precipitation, which, combined with favorable temperature, makes ideal weather conditions for the sowing of rice.

TABLE 10.—*General climatological data at the Rice Experiment Station, Crowley, La., for each week from April 1 to June 16, inclusive, during the 14-year period from 1910 to 1923, inclusive*

Weather conditions	Apr. 1 to 7	Apr. 8 to 14	Apr. 15 to 21	Apr. 22 to 28	Apr. 29 to May 5	May 6 to 12	May 13 to 19	May 20 to 26	May 27 to June 2	June 3 to 9	June 10 to 16
Temperature (° F.):											
Maximum	87	88	88	90	90	92	93	94	98	100	102
Minimum	32	34	39	34	41	43	50	50	57	57	56
Weekly mean	66	66	69	70	71	72	73	75	79	80	80
Precipitation (inches):											
Average	0.75	0.90	1.08	1.05	0.88	0.78	0.89	1.41	0.74	1.37	0.81
Average number of days with 0.01 inch or more	2.1	1.5	2.1	1.7	1.7	1.8	1.7	1.7	1.9	2.6	2.3
Wind velocity (miles per hour):											
Maximum	10.1	9.5	9.8	10.0	8.1	6.8	8.4	7.9	9.1	8.6	10.9
Minimum	.3	1.8	.8	1.0	.9	.6	.4	.8	.3	.2	.7
Average	4.2	4.6	4.1	3.8	3.5	3.2	3.2	3.3	2.7	2.6	2.7

Earlier seeding than the best approximate date (May 14), especially on land that is foul with weeds, often results in a weedy crop. Seeds of many rice-field weeds germinate before or with the rice when the crop is sown in April. This foreign growth always affects the stand, and the competition reduces the yield.

The tillage that is required in the preparation of the land for seeding in early May has a tendency to control those weeds which germinate at a lower temperature than rice. Weedy fields should be lightly disked repeatedly until May 10, and later if necessary. Such fields should never be sown without this tillage nor at an earlier date than May 15.

RATE AND METHOD OF SEEDING

Rate-of-seeding experiments were conducted to determine the quantity of well-matured and recleaned seed necessary to secure optimum stands and maximum yields. For these experiments the land was plowed in winter to a depth of 5 to 7 inches and seed sown approximately May 1, broadcast and by drill, at varying rates on a smooth seed bed. The drilled seed was sown at a depth of 2 inches, and the broadcasted seed was harrowed in. The data on both drilled and broadcast seedings are given in Table 11. The largest average acre yield was obtained when seed was sown with a drill at the rate of 80 pounds per acre, although the yield from the 100-pound drilled seeding was practically the same. For the entire 6-year period the average yields slightly favor the drilled seedings. The result is not consistent for every season, owing to the effect of seasonal conditions.

TABLE 11.—*Annual and average yields of Wataribune rice obtained in the rate-of-seeding experiments at the Rice Experiment Station, Crowley, La., during the 6-year period from 1917 to 1922, inclusive*

Method and rate of seeding per acre	Yields per acre (pounds)							
	Annual						Average for years stated (dates inclusive)	
	1917	1918	1919	1920	1921	1922	4 years, 1917 to 1920	6 years, 1917 to 1922
Seed drilled:								
60 pounds	1,300	1,680	1,470	2,060	3,060	1,890	1,628	1,910
80 pounds	1,780	2,760	1,680	2,600	2,810	2,040	2,205	2,278
100 pounds	1,980	2,750	1,600	2,240	2,700	2,290	2,143	2,260
Seed sown broadcast:								
60 pounds	2,100	1,450	2,340	2,510			2,100	
80 pounds	2,100	1,300	2,130	2,400	1,700	1,080	1,983	1,785
100 pounds	2,640	1,550	2,750	2,680	1,520	1,400	2,405	2,090

The quantity of rice seed that may be required to obtain a good stand depends upon many factors, but mainly on the kind of bed upon which the seed is to be sown and the date of seeding. If the seed bed has been well prepared, good germination always results when the seed is sown after May 1. Less seed is necessary under such conditions than on a rough and cloddy seed bed, where the seed can not be evenly and uniformly distributed in the moist soil. If the date of seeding is earlier than May 1, the rate of seeding should be increased relatively, because the cold rains which are frequent before that date often cause a large percentage of the seed to rot. A larger quantity of seed also is needed to sow land that is very weedy. The long-grain varieties of rice, which do not usually tiller as freely as the short-grain varieties, probably also should be sown at a greater rate per acre. Preliminary experiments, however, indicate that even with long-grain varieties 100 pounds of seed, when sown under favorable soil and weather conditions, is sufficient to give a stand that will produce large yields.

DEPTH OF SEEDING

The depth to which rice seed is sown has an effect upon stand and yield. For the depth-of-seeding experiments the land was plowed in winter to a depth of 5 to 7 inches and the seed sown approximately May 1 on a smooth seed bed by a drill at varying depths at the rate of 80 pounds per acre. The data in Table 12 show that for the entire 8-year period the largest average yields of rice were obtained from sowing at the depth of 1 inch. The yields, however, vary with the season, since the weather both before and after seeding has an important effect upon the condition of the seed bed.

TABLE 12.—*Annual and average yields of rice*[1] *obtained in the depth-of-seeding experiments at the Rice Experiment Station, Crowley, La., during the 8-year period from 1913 to 1920, inclusive*

Depth of seeding	Yields per acre (pounds)										
	Annual								Average for years stated (dates inclusive)		
	1913	1914	1915	1916	1917	1918	1919	1920	4 years, 1913 to 1916	4 years, 1917 to 1920	8 years, 1913 to 1920
1 inch	2,640	1,650	1,900	1,200	1,700	2,980	1,890	2,510	1,848	2,270	2,059
2 inches	2,610	1,530	2,000	1,070	1,780	2,760	1,680	2,600	1,803	2,205	2,004
3 inches	1,860	1,750	2,000	1,000	1,930	2,200	1,240	2,150	1,653	*1,880	1,766

[1] During the 4-year period from 1913 to 1916, inclusive, the Honduras variety was used in these experiments, and during the 4-year period from 1917 to 1920, inclusive, the Wataribune variety was used.

A seed bed in a good physical condition usually retains enough moisture and heat during the first two weeks of May for good germination when rice seed is sown at a depth of 1 or 2 inches. On such a seed bed any compacting of the soil that may result from heavy rains occurring shortly after seeding is not likely to retard seriously the emergence of the young plants if the seed is not sown to a depth greater than 1 inch. The soil crust that may be formed will readily crack under the drying effect of the sun and wind and is not likely to interfere with the normal growth of the young plants. Deeper seeding, however, increases the danger of delayed germination. Any condition that affects uniform emergence has a correspondingly bad effect upon the stand.

The depth of seeding should always be shallow in a dry soil. This will prevent germination without rain or until irrigation water can be applied, and it insures a good stand if the seed bed is properly prepared and good seed is used.

FERTILITY EXPERIMENTS

When commercial rice growing first began in southwestern Louisiana in 1885 the virgin sod land, richly supplied with plant food, produced large yields of rice. These yields and the low price of land attracted the attention of many grain farmers from the upper Mississippi Valley who were seeking southern land. These men applied so far as possible their methods of wheat culture to the growing of rice, and even without experience in rice culture they produced crops at a comparatively low cost. The yields obtained, the comparatively low cost of production, and the ready market for rice products attracted the attention of capitalists, who freely in-

vested their money in extending and improving the canal systems, in building rice mills, and in purchasing large tracts of land. The renting of these lands on short-term leases became the accepted custom in this section of the State.

The system of farming on short-term leases centered on immediate returns, regardless of the effect upon the land or the future status of the rice industry. No effort was made to control weeds or to maintain production. As long as there was an abundance of virgin soil, neither farmer nor landlord gave any attention to conserving soil fertility. Within less than two decades the cultural methods practiced during the early years of rice growing greatly reduced the plant food of these prairie soils and likewise seriously affected production. On account of low yields, a large part of each farm remained unplowed for a time. However, it was soon noted that these soils responded profitably to cultivation when prepared for rice after a complete rest of three years. This observation led to the general practice of grazing lands which had been cropped to rice for three to five years. Production improved somewhat under such treatment, but weeds, especially red rice, were not brought under control. The acreage that was not under cultivation was often too large to be grazed closely enough by available cattle to have much effect in the control of red rice. This weed survived under pasture conditions and especially on poorly drained land. Commercial fertilizers also were used by many tenant farmers in the belief that yields could be maintained regardless of poor soil preparation, but these methods resulted in yields that did not warrant the expense of applying fertilizers. Later it was noted that good crops were produced on well-drained soils when given good preparation.

The experiments here discussed were designed to determine the value of commercial fertilizers on Crowley silt loam and the proper procedure for maintaining soil fertility. The land used for these experiments was well drained and was practically free from weed growth. Prior to 1918 the land had been sown to rice in rotation with soybeans, the season of 1918 being the last in which soybeans were grown. As a result of this rotation and the practice of turning under the mature soybean plants after harvesting the beans, the soil was in good physical condition and was well supplied with organic matter at the beginning of the fertilizer experiments. Plowing was done in winter to a depth of 5 to 7 inches. The fertilizers were applied broadcast by hand and harrowed in before seeding. The manure was applied in the same way but was disked in before seeding. Each plat being inclosed by levees and irrigated and drained independently, the fertilizers were not conveyed beyond the limits of the individual plats. The rice was sown approximately on May 1 in a well-prepared seed bed with a drill at a depth of 2 inches and at a rate of 80 pounds of seed per acre. In this experiment the Wataribune variety was used. The results are given in Table 13.

Acid phosphate containing 16 per cent of available phosphoric acid did not increase the yield of rice either when applied alone or with other fertilizers. The low yields that were obtained from the use of acid phosphate may be explained in part by increased weed growth, especially sedges, which invariably followed an application of this fertilizer either alone or in combination. Even the winter growth of weeds on plowed land was more noticeable on plats receiv-

ing acid phosphate than on those plats which were not so treated. Several species of sedges in particular respond to a marked degree whenever acid phosphate is applied, except when lime is used. During all stages of their growth the rice plants growing on plats receiving acid phosphate were also more susceptible to the disease caused by the fungus *Piricularia oryzae* than plants on plats not so fertilized. Rice plants so affected are crowded out by weed growth. In commercial fields low yields that are usually attributed to other causes are largely due to this disease. The effect of this disease was particularly marked in 1919 and 1921, when yields on the phosphate-fertilized plats were much reduced by this fungus. In addition, whenever germination was delayed good stands were not obtained on plats to which acid phosphate had been applied. The seed apparently was injured by this fertilizer. On the other hand, during the first two weeks after emergence the plants on the phosphate-fertilized plats were vigorous and dark green in color. As soon as irrigation water was applied, however, they became very unhealthy in appearance. This effect was noticeable even where the least amount of acid phosphate was used. On plats where other fertilizers were used this effect was not noted.

TABLE 13.—*Annual and average yields of Wataribune rice obtained in the fertilizer experiments and in rotation with the Biloxi soybean on duplicated tenth-acre plats at the Rice Experiment Station, Crowley, La., in the 5-year period from 1919 to 1923, inclusive*

Sources of plant food	Fertilizers applied per acre (pounds)	Yields per acre (pounds)					
		1919	1920	1921	1922	1923	Average
Acid phosphate	350	790	1,710	545	1,605	1,050	1,140
No fertilizer		2,000	1,420	1,375	1,590	1,150	1,507
Sulphate of ammonia	100	1,780	1,390	1,200	1,370	1,020	1,352
Nitrate of soda	120	1,800	1,390	1,160	1,370	900	1,324
Cottonseed meal	280	1,980	1,250	1,050	1,590	1,170	1,408
Dried blood	160	2,130	1,515	1,315	1,555	1,205	1,544
Sulphate of potash	100	1,850	1,725	1,485	1,605	1,125	1,558
Acid phosphate	350	620	1,720	885	1,380	1,140	1,149
Sulphate of ammonia	100						
Acid phosphate	350	800	1,610	1,095	1,400	1,135	1,208
Sulphate of potash	100						
No fertilizer		1,760	1,645	1,215	1,370	980	1,394
Sulphate of ammonia	100	1,780	2,000	1,540	1,660	1,230	1,642
Sulphate of potash	100						
Acid phosphate	350	510	1,825	815	1,845	1,170	1,233
Sulphate of ammonia	100						
Sulphate of potash	100						
Limestone	2,000	1,850	1,515	1,680	1,495	1,020	1,512
Do	4,000	1,955	1,410	1,675	1,340	910	1,458
Do	6,000	1,805	1,275	1,330	890	490	1,158
Do	4,000	1,315	1,895	1,585	1,205	1,070	1,414
Acid phosphate	350						
Sulphate of ammonia	100						
Sulphate of potash	100						
No fertilizer		1,515	1,570	1,490	1,320	1,170	1,413
Manure, horse	2,000	1,585	1,785	1,605	1,440	1,280	1,539
Biloxi soybean plowed under after beans were harvested		2,340	2,920	2,320	2,325	1,860	2,353

It is evident from the yields shown in Table 13 that dried blood may be advantageously applied as a source of nitrogen for rice when a legume is not used to supply this plant food. The dried blood used in these experiments contained on an average 16 per cent of nitrogen. A larger quantity of dried blood probably would not increase the yield appreciably and might stimulate the growth of the plant to such an extent as to cause lodging.

Sulphate of ammonia, nitrate of soda, and cottonseed meal also were used in these experiments as sources of nitrogen, but when applied alone they did not increase yields. Sulphate of ammonia applied at the rate of 100 pounds per acre with 100 pounds of sulphate of potash, however, caused an increase in yield slightly above that produced by sulphate of potash alone.

Sulphate of potash applied at the rate of 100 pounds per acre produced an increase in yield when used alone and with sulphate of ammonia. These yields might be interpreted to mean that the Crowley silt loam is deficient in potassium, yet the increased yields obtained after a crop of soybeans indicate that this element probably is present in sufficient quantities to meet the requirements of rice and becomes available when vegetable matter is added to the soil.

An application of 2,000 pounds of horse manure gave a greater average yield of rice than was obtained from plats that did not receive any kind of fertilizer. Manure is an excellent source of plant food, and its effect on the physical condition of the soil and the availability of soil plant food is beneficial. The quantity of horse manure on a rice farm, however, is too small to be of practical service to the producer of rice.

In the experiment to determine the effect of lime on the yield of rice, limestone was applied only in 1919, 1920, and 1923. The low yields obtained after this treatment in 1920 probably were due to an excess of lime, and on that interpretation no limestone was applied in 1921 and 1922. The better yields of 1921 probably were due to the removal of any excess of lime added to the soil in 1919 and 1920 and to the stimulating effect from the smaller quantity still remaining in the soil. In 1923 limestone did not increase the yield of rice. Limestone at the rate of 6,000 pounds per acre retards the growth of the young rice plants. The same effect is produced when limestone is applied each year at the rate of 2,000 and 4,000 pounds per acre. Sedges which often become troublesome weeds are greatly reduced in number when lime is applied. The results indicate that the yield of rice may be increased by the application of limited quantities of limestone at intervals of several years.

The average yield of rice obtained from the use of a complete commercial fertilizer was 205 pounds less than the average yield obtained without the use of any fertilizer. A complete commercial fertilizer with limestone at 4,000 pounds per acre produced a larger average yield than with no limestone but still 24 pounds less than the average yield when no fertilizer was used.

The best yields of rice in these experiments were obtained not by the use of fertilizers but by growing the crop in rotation with soybeans. The data show that yields produced from the use of manure and limestone and from the use of commercial fertilizers applied alone and in combination were each year much smaller than the yields when the crop was grown in the soybean rotation. With the exception of dried blood and sulphate of potash alone and in combination with sulphate of ammonia, the use of commercial fertilizers did not increase rice yields on Crowley silt loam which had been effectively drained and well prepared for seeding, whereas the turning under of the mature soybean plants greatly increased rice yields.

An average yield of 2,353 pounds of rice per acre was secured when the crop was grown in rotation with soybeans. This yield is

1,213 pounds greater than the average yield obtained by the use of acid phosphate alone. It also is 711 pounds greater than the average yield from the combination of sulphate of ammonia and sulphate of potash, which gave the highest yield of any commercial fertilizer that was applied. At the beginning of these experiments this soil was well supplied with organic matter and in a good physical condition, owing to the previous growing of soybeans. The production of the season of 1919 was not maintained, because the soybean cropping was discontinued. At the end of five years the unfertilized plats produced an average acre yield of 915 pounds less than the plats where the soybean rotation was continued. From these experiments it is safe to conclude that the Crowley silt loam is not as yet deficient in mineral plant foods and that yields may be maintained and increased if this soil is adequately drained and supplied with organic matter.

A virgin soil is fertile because of the availability of the plant-food elements. In the cultivation of the soil the plant food is removed year by year through leaching and by the growing crops. It must be replaced or the mineral elements within the soil must be made available if profitable production is to be maintained.

Plant food is made available by chemical and biological processes which take place naturally in an aerated soil supplied with humus. The products of these processes include various organic and inorganic acids which are effective as solvents for the mineral plant food. The production of these solvents is greater in soils with a supply of humus than in soils deficient in decayed organic matter.

Humus, which is so essential for soil fertility, is the product of decomposed organic matter that has lost the physical structure of the materials from which it was made and has been thoroughly incorporated in the soil mass. Its supply can be increased in the prairie soils of southwestern Louisiana by growing the Biloxi soybean, to be plowed under after harvest. Any legume that will grow well under rice-field conditions may be used for the same purpose.

During the early period of the rice industry in southwestern Louisiana the natural drainage of these level prairies was not sufficient to permit the proper preparation of the land for seeding or for harvesting the crop. This was shown in poor average stands and in losses that always occurred at harvest, because irrigation water could not be removed promptly enough for the use of machinery before the grain began to shatter. About 15 years ago, however, the importance of efficient drainage was recognized, and drainage districts were organized. These projects resulted in an important general improvement in the rice-producing areas. Subsequent experience has shown that the soils of these prairies when well drained respond to good tillage and produce good crops of rice without the use of commercial fertilizers. The average yield of 33.7 bushels of rice per acre for southwestern Louisiana during the 13-year period from 1911 to 1923, inclusive, has been maintained largely by the better soil conditions produced by good drainage.

IRRIGATION EXPERIMENTS

Fresh water in large quantities is needed to meet the requirements of the rice crop. In southwestern Louisiana the supply must be large

enough to cover the land under cultivation to a depth of 6 or 8 inches for at least 90 days and must be available during May, June, July, August, and September. During normal seasons the precipitation and the water from streams and deep wells in this area are adequate to supply irrigation for approximately a million acres. Dry seasons, however, reduce this total and limit the rice crop to a much smaller acreage.

In a section where there is abundant rainfall an extravagant use of water is to be expected and probably will be very difficult to prevent. The delivery of irrigation water for rice in southwestern Louisiana has ceased to be a problem. It has been so satisfactorily solved that if the payment for water could be based upon volume used instead of some form of crop rental the rice farmers of this section could probably compete with any rice area in the world. A cash rental, however, can not be put in practice until the farmers become impressed with the importance of conserving water.

The depth and character of the soil, imperviousness of the subsoil, compactness of levees, depth of submergence, and the length of the growing season are the factors that determine the quantity of water which must be supplied to a field of rice to obtain profitable production. Shallow clay soils are best adapted to rice culture. They require less water to maintain a given depth of submergence and lose less water by seepage than soils lighter in texture. On account of the abundance of water in southwestern Louisiana many soils of lighter type are used for rice; but if the water supply should ever be diminished the crop would ultimately be confined to the shallow clay types with impervious subsoils, because of the smaller quantity of water required for their irrigation. Clay soils also are useful in constructing water-tight levees, an important consideration in conserving irrigation water. If the outside levees are broad and firmly constructed of a compact clay soil, seepage may become a negligible factor. Levees should be permanent and constructed on contour lines at distances which will hold the water at an average depth of 6 to 8 inches. Their efficiency in controlling the field water depends largely upon their structure. They should be at least 12 feet wide at the base and built with broadly sloping sides to a height just sufficient to prevent the water from overflowing into the fields below. Levees of this construction are practically submerged during the irrigation period. There is no seepage through them after they have become saturated and thoroughly settled. On account of their height, they also can be brought under cultivation and sown to rice, preventing a waste of land and leaving no uncultivated strips for the growth of weeds.

The general practice is to seed the crop early and to supply irrigation water approximately 10 days after emergence. The depth of the water at the time of submergence and at subsequent applications often varies greatly even under the same management. The time of applying irrigation water and the depth of submergence are factors which should be more carefully considered, since they determine the quantity of water used and also have an effect on yield.

The irrigation experiments at the Rice Experiment Station were conducted on plats 1 square rod in size. The plats were arranged side by side in one series. Each plat was completely inclosed by high levees. Low levees, which are preferable, would have required

more land than was available. Each plat was irrigated and drained independently through a gate.

Since the plats were too small to permit plowing, the land was spaded in winter to a depth of 5 to 7 inches and in the spring was thoroughly prepared by hand before seeding the crop. A good seed bed was always obtained. The seed was sown with a garden drill in rows 8 inches apart at the rate of 80 pounds per acre. The soybean rotation was not used in these experiments.

DATE OF SUBMERGENCE

Data showing the effect of date of submergence on yield are given in Table 14. The largest average yields, as shown by these data, were obtained on land that was submerged 15 days after the rice plants emerged. The average yield obtained by submergence at this time was 720 pounds greater than that obtained by submerging 15 days later. With each successive later date of submergence there was further reduction in average yield. This reduction in yield was largely due to increase in weed growth. Although early submergence has a beneficial effect in the control of many weeds, other experiments here discussed show that weeds can be more effectively controlled by growing rice in rotation with soybeans, and when this practice was followed submergence could be delayed 30 days after emergence with no apparent loss in yield.

TABLE 14.—*Annual and average yields of Wataribune rice obtained in the date-of-submergence experiments on square-rod plats at the Rice Experiment Station, Crowley, La., in the years 1917, 1918, and 1919*

Submergence	Yields per acre (pounds) when submerged 4 inches			
	1917	1918	1919	Average
15 days after emergence	2,080	1,920	4,480	2,827
30 days after emergence	1,280	1,520	3,520	2,107
45 days after emergence	1,840	1,600	2,240	1,893
60 days after emergence	1,280	1,560	1,760	1,533

DEPTH OF SUBMERGENCE

In Table 15 are given yield data for the depth-of-submergence experiments for 1917, 1918, and 1919. These data show that the greatest average yield of rice was obtained from submerging 8 inches, although the highest individual annual yield was obtained in 1919 from a 2-inch submergence. Under field conditions preference should be given to the deeper submergence, however, because it is more easily maintained. Unless the land is exceedingly level and the levees carefully constructed, the usual fluctuations in the depth of water during the period of irrigation probably would damage the crop in a submergence as shallow as 2 inches. A submergence of 8 inches probably is the greatest depth of water that is ever necessary, while a depth of 6 or even 4 inches may be sufficient on very level land where low levees are used, if submergence can be easily maintained. At the Rice Experiment Station a submergence of 6 inches of water is used in ordinary practice.

Data showing the average quantity of water, including precipitation, used in the depth-of-submergence experiments during 1917,

1918, and 1919 are given in Table 15. These data show that the plats which were submerged to the depth of 2, 4, 6, and 8 inches received on the average 23.29, 23.31, 24.05, and 37.21 inches of water, respectively. The average quantity used in the first three depths of submergence was approximately the same. The greater quantity used on the plats submerged to a depth of 8 inches was very likely due to greater seepage. Evaporation and transpiration undoubtedly were practically the same for all depths of submergence, so the difference must have been due to seepage.

TABLE 15.—*Seasonal and average irrigation data for the 3-month period of July, August, and September and annual and average yields of Wataribune rice obtained in the depth-of-submergence experiments on square-rod plats at the Rice Experiment Station, Crowley, La., in 1917, 1918, and 1919*

Year	Irrigation water (inches)				Days of submergence	Precipitation during submergence (inches)	Quantity of water used (inches)	Yields per acre (pounds)
	Depth[1]	Applied to maintain stated depth	Average daily loss	Estimated total loss				
1917	2	13.56	0.393	27.510	70	14.31	29.87	1,520
1918	2	12.21	.323	22.610	70	10.63	24.84	1,520
1919	2	3.54	.233	12.815	55	9.62	15.16	3,360
Average		9.77	.316	20.540	65	11.52	23.29	2,133
1917	4	7.23	.299	20.930	70	14.31	25.54	1,920
1918	4	6.12	.246	17.220	70	10.63	20.75	1,520
1919	4	10.01	.341	18.755	55	9.62	23.63	2,080
Average		7.79	.295	19.175	65	11.52	23.31	1,840
1917	6	8.09	.319	22.330	70	14.31	28.40	1,760
1918	6	4.73	.232	16.240	70	10.63	21.36	1,360
1919	6	6.75	.290	15.950	55	9.62	22.37	2,880
Average		6.53	.280	18.200	65	11.52	24.05	2,000
1917	8	16.85	.441	30.870	70	14.31	39.16	1,840
1918	8	26.98	.517	36.190	70	10.63	45.61	2,000
1919	8	9.26	.357	19.635	55	9.62	26.88	3,020
Average		17.69	.438	28.470	65	11.52	37.21	2,287

[1] Water required for the saturation of the soil prior to submergence was not measured.

Table 15 shows that for the 3-year period these plats received, respectively, exclusive of precipitation, the average quantity of 9.77, 7.79, 6.53, and 17.69 inches of water to replace losses from evaporation, transpiration, and seepage. On account of the greater seepage from the plat having a submergence of 8 inches, a larger quantity of water was applied to it than to the other plats for maintaining the proper depth.

The data given in Table 15 further show that during the same period the average total loss of water from the plats submerged 2, 4, 6, and 8 inches was, respectively, 20.540, 19.175, 18.200, and 28.470 inches. This total loss was based on the respective daily losses of 0.316, 0.295, 0.280, and 0.438 inch of water.

The loss of water from the plats and the quantity of water, including precipitation, applied to the plats in the depth-of-submergence experiments were accurately measured by a micrometer gauge. The gauge was set at the time of reading on the top of a galvanized-iron still well, 3 inches in diameter, which was firmly placed in the soil in each plat among the rice plants about 3 feet from the levee. Per-

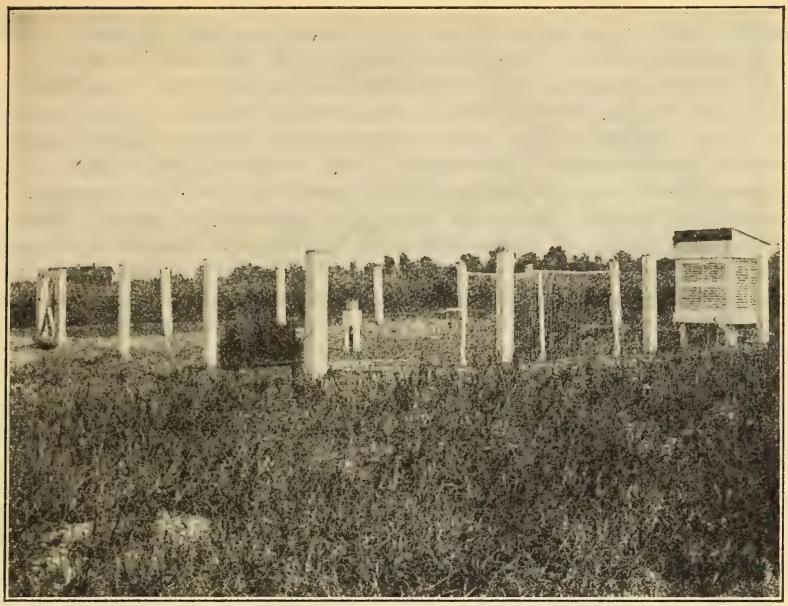

FIG. 5.—The weather-instrument inclosure at the Rice Experiment Station, Crowley, La., showing evaporation tanks, rain gauge, anemometer, and the thermometer shelter containing instruments for recording the temperature and humidity of the air

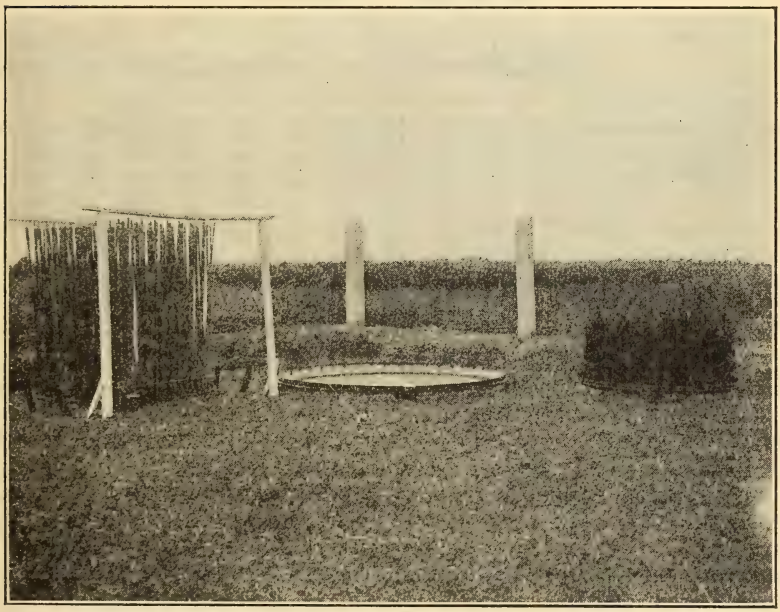

FIG. 6.—A part of the weather-instrument inclosure at the Rice Experiment Station, Crowley, La., showing evaporation tanks. (See Table 16)

forations in the wall of the still well below the water surface permitted water to enter and pass out freely, so that the water in the still well and that on the plats was always at the same level.

In determining the quantity and manner of water loss from the plats, the losses by evaporation and transpiration were based upon the data obtained from three evaporation tanks. These tanks, 6 feet in diameter and 2 feet deep (figs. 5 and 6), were sunk in the ground, their tops projecting about 2 inches above the surface. The water level in each tank was kept approximately 4 inches from the top of the tank. A brass still well having a diameter of 3 inches was attached externally to each tank by a supporting bracket, the tank and still well being connected by a half-inch pipe. The quantity of water that was applied and lost by evaporation and transpiration was measured with a micrometer gauge.

Tank A had a freely exposed water surface. The water surface in tank B was shaded by flat wooden slats half an inch in width and 40 inches in length. The slats were suspended from fine wires stretched across the tank, leaving their ends about 1 inch above the water. They were arranged in rows 8 inches apart and tied together at their lower ends to approximate in effect the shade of the rice plants. Tank C contained soil in which rice was grown in rows 8 inches apart and in water 6 inches deep.

TABLE 16.—*Average daily loss of water from tanks A, B, and C at the Rice Experiment Station, Crowley, La., for July, August, and September and for that 3-month period of each year from 1910 to 1922, inclusive*

[Data in inches]

Year	Tank not shaded				Tank shaded by slats				Tank shaded by rice plants			
	July	Aug.	Sept.	Average	July	Aug.	Sept.	Average	July	Aug.	Sept.	Average
1910	0.179	0.174	0.153	0.169	0.109	0.107	0.102	0.106	0.206	0.281	0.330	0.272
1911	.179	.175	.138	.164	.111	.093	.078	.094	.230	.308	.239	.259
1912	.164	.185	.139	.163	.102	.085	.094	.094	.207	.495	.416	.373
1913	.175	.172	.126	.157	.087	.112	.059	.099	.184	.293	.231	.236
1914	.197	.143	.171	.170	.121	.097	.129	.116	.284	.214	.294	.264
1915	.213	.193	.162	.189	.121	.157	.118	.132	.260	.240	.300	.267
1916	.185	.168	.169	.174	.113	.121	.096	.110	.313	.424	.382	.373
1917	.194	.182	.161	.179	.128	.115	.109	.117	.264	.261	.228	.251
1918	.219	.184	.176	.193	------	------	------	------	.238	.294	.330	.287
1919	.169	.174	.170	.171	------	------	------	------	.195	.316	.313	.275
1920	.141	.178	.175	.165	------	------	------	------	.238	.332	.346	.305
1921	.160	.209	.137	.169	------	------	------	------	.189	.217	.166	.191
1922	.181	.188	.155	.175	------	------	------	------	.210	.269	.263	.247
Average, 1910–1917	.186	.174	.152	.171	.112	.111	.103	.109	.244	.315	.303	.287
Average, 1910–1922	.181	.179	.156	.172	------	------	------	------	.232	.303	.295	.277

Table 16 shows the average daily loss of water from the tanks shown in Figure 6 for July, August, September, and also for this 3-month period of each year from 1910 to 1922, inclusive.

The loss from tank A was by evaporation from a freely exposed water surface and is taken to represent the loss of water by evaporation from reservoirs, canals, large laterals, and small ditches. The greatest average daily evaporation occurred in July for the 3-month period from 1910 to 1922, inclusive, as shown in Table 16. The maximum, minimum, and average monthly and daily evaporation at the Rice Experiment Station for the 14-year period from 1910 to 1923, inclusive, is given in Table 6.

The loss of water from tank B is assumed to represent the loss of water by evaporation from a rice field during submergence. The data presented indicate that the actual evaporation from a rice field in July, August, and September varies but little from month to month, on account of the uniform conditions produced by the shade of the rice plants.

The loss of water from tank C represents evaporation from a body of water shaded by rice plants and also transpiration by the plants. The loss from tank C minus the loss from tank B is assumed to represent the loss of water by transpiration. The data given in Table 16 indicate that the average daily loss of water by transpiration is greatest in August and September. The total loss of water from the rice plats during submergence minus evaporation and transpiration based on the data from tank C is assumed to represent the loss of water by seepage. In Table 17 are given data assumed to represent the average daily loss of water by evaporation and by transpiration from a rice field during the 3-month irrigation period of each year from 1910 to 1917, inclusive. The average daily loss of water by seepage and by assumed evaporation and transpiration from plats in the depth-of-submergence experiments for the 3-month period for 1917, 1918, and 1919 are given in Table 18.

TABLE 17.—*Average daily loss of water by evaporation and transpiration from tanks B and C at the Rice Experiment Station, Crowley, La., for July, August, and September of each year from 1910 to 1917, inclusive*

[Data in inches]

Loss of water	1910	1911	1912	1913	1914	1915	1916	1917	Average
Total by evaporation and transpiration from tank C	0.272	0.259	0.373	0.236	0.264	0.267	0.373	0.251	0.287
By evaporation from tank B	.106	.094	.094	.099	.116	.132	.110	.117	.109
By transpiration from tank C	.166	.165	.279	.137	.148	.135	.263	.134	.178

TABLE 18.—*Average daily loss of water by seepage and evaporation and transpiration from plats in the depth-of-submergence experiments at the Rice Experiment Station, Crowley, La., for July, August, and September for 1917, 1918, and 1919*

[Data in inches]

Loss of water	Depth of submergence (inches)			
	2	4	6	8
Total	0.316	0.295	0.280	0.438
By evaporation and transpiration [1] inches	.271	.271	.271	.271
By seepage do	.045	.024	.009	.167

[1] Average daily loss of water from tank C for the 3-month period for 1917, 1918, and 1919. (See Table 16.)

Daily seepage from the different plats varied in these experiments from 0.009 to 0.167 inch. Theoretically, seepage should be proportional to depth of submergence. The data of Table 18 agree with this theory only in the loss of water by seepage from the plat submerged 8 inches. In these experiments it was not possible to use the broad levees ordinarily used in field practice, and the high narrow levees cracked to a greater or less extent in drying. Because of variations in cracking, the losses from the plats submerged 2, 4, and 6 inches show no relation to the depth factor. The elements

of error in the data make conclusions unsafe. Under field conditions the use of broad levees would greatly reduce seepage.

ROTATION EXPERIMENTS

Crop rotation has not been a factor in rice culture in southwestern Louisiana because of the outstanding value of rice and the unwillingness of farmers to grow other crops which are not equally remunerative. Other crops grown are of secondary importance and are not a part of any established or intended rotation. The only recognition of the principle of crop succession in this section is the pasturing of rice fields after several years of cropping. Good tillage and drainage have maintained production at a fair average yield, but that this yield can be increased and the higher yield maintained by proper rotation is shown by experimental data obtained at the Rice Experiment Station. In Table 19 are given annual and average yield data for rice grown in rotation with soybeans and on land continuously cropped to rice during the 11-year period from 1913 to 1923, inclusive.

TABLE 19.—*Annual and average yields of rice*[1] *grown in rotation with soybeans and on land cropped continuously to rice at the Rice Experiment Station, Crowley, La., during the 11-year period from 1913 to 1923, inclusive*

Manner of cropping	Yields per acre (pounds)													
	Annual											Average for years stated (date inclusive)		
	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	6 years, 1913–1918	5 years, 1919–1923	11 years, 1913–1923
In rotation with soybeans[2]	2,940	2,020	2,166	2,230	2,457	2,000	3,080	3,240	1,830	2,400	1,860	2,302	2,482	2,384
Continuously to rice since 1909	2,298	2,223	1,250	818	957	1,226	1,113	1,225	1,263	690	610	1,462	980	1,243

[1] From 1913 to 1918, inclusive, the Honduras variety, and from 1919 to 1923, inclusive, the Wataribune variety, were grown in the experiments.
[2] The rotation began in 1912. The Barchet variety of soybeans was grown in 1913 and 1914 and the Biloxi variety from 1915 to 1923, inclusive.

For the 6-year period from 1913 to 1918, inclusive, the Honduras variety grown in rotation with soybeans produced an average annual acre yield of 840 pounds larger than that produced where it was grown continuously. The higher yielding Wataribune variety produced during the 5-year period from 1919 to 1923, inclusive, an average annual acre yield 1,502 pounds larger than that produced where it was grown continuously. Allowing for differences in annual yields due to seasonal variations, larger yields were obtained and also maintained by the soybean rotation. Efficient drainage and good tillage, supplemented by the organic matter added to the soil by plowing under mature soybean plants after harvest, gave returns which were not obtained from commercial fertilizers.

Increased yields were not the only advantage of the soybean rotation. When combined with good drainage the decomposed organic matter which was supplied by the soybean plants when plowed under put the soil in a loose and friable condition (fig. 7). The upturned soil readily responded to tillage in preparing a suitable seed bed for rice. Such a seed bed is not easily obtained, even with extra tillage, when the soil is deficient in organic matter (fig. 8).

FIG. 7.—Land to which vegetable matter has been added in autumn or winter by plowing under mature soybean plants. Such soil is loose, friable, and easily prepared in the spring

FIG. 8.—Land upon which rice stubble has been plowed under without having grown soybeans. Such soil is cloddy and difficult to prepare in the spring

The beneficial effect of the organic matter in the soil was also shown in other ways. Where soybeans had been grown moisture was more effectively retained in the soil during and immediately after seeding. It was therefore seldom necessary to apply irrigation water earlier than 30 days after emergence of the rice plants. The early growth of the crop also was very vigorous, which indicated greater fertility and generally improved soil conditions.

When grown in rotation with rice, soybeans should be sown on land plowed during the previous winter to a depth of at least 5 inches. The plowed land should be disked several times in the spring before seeding. This tillage has an important bearing on

FIG. 9.—A plat of Biloxi soybeans at the Rice Experiment Station, Crowley, La., October 2, 1919. The seed was sown June 15, and the beans were harvested November 10

the control of weeds. If repeated several times during April and early May, weeds of many species and especially red rice will be destroyed before the soybean crop is sown.

Sowing soybeans on high ridges, as is done with corn in this section of Louisiana, is not desirable. The high ridges interfere with cultivating and harvesting the crop. A slight ridge, however, may be an advantage in preventing water from settling on the seed when heavy rains occur after seeding. This type of ridge may also serve as a useful guide in seeding and cultivating the crop. The ridges may be made with a riding disk cultivator. This implement usually pulverizes the soil so well that the only additional preparation required before seeding is to level the ridges slightly with a drag or float.

Experiments show that soybeans should be sown in rows 4 feet apart and at the rate of 30 pounds of seed per acre. Seeding may

be done with an ordinary corn planter adjusted to drop one or two seeds from 2 to 4 inches apart in the row. The seed should be sown just beneath the soil surface. Deeper seeding is likely to result in a loss of stand.

The Biloxi is better adapted to rice-field conditions than any other variety of soybean that so far has been tested at the Rice Experiment Station. This variety should be sown not earlier than the last week in May, and preferably not later than June 15. When sown during this period the plants are relatively short (fig. 9) and bear short limbs that fruit rather heavily. Plants of this type are easily and effectively cultivated and can be harvested with machinery without appreciable loss. When sown earlier than the week mentioned, the Biloxi variety grows very tall and bears large limbs. These limbs seriously interfere with cultivation, preventing the destruction of many weeds. The larger plants also are not likely to be more productive. Early seeding has little effect on date of maturity, which with the Biloxi normally occurs in early November.

Good cultivation is essential. Cultivation may be done with a riding cultivator and should begin as soon as the plants can be readily traced in the rows. By using the disk and other attachments alternately the soil can be kept in such tilth that red rice and other weed seeds germinate quickly and are killed by subsequent tillage. The control and eradication of weeds depend upon the frequency and thoroughness of cultivation, which should be continued as long as weed growth is noticeable.

The seed of the Biloxi variety does not shatter at maturity. The leaves drop when the plants have matured, but the pods remain closed and firmly attached. The crop should be harvested after the leaves have fallen, but not until the pods will open readily when pressed between the fingers. The pods, however, do not dehisce readily shortly after the leaves have fallen, and if there is too much delay in harvesting the beans may not shell out readily in threshing. A delay in harvesting, therefore, may either cause loss or require extra labor in shelling the beans.

In addition to increasing and maintaining the production of rice when included in the rotation, soybeans are useful in bringing weeds under control. The frequent cultivation they require will destroy many aquatic and semiaquatic weeds, especially red rice, even during the first season. If continued through five soybean crop years, the worst rice-field weeds may be brought under control or completely eradicated. During this period it will not be necessary to have an unproductive acre of land at any time.

One of the worst weeds which is effectively controlled by the soybean rotation is red rice. This extremely noxious weed was introduced into southwestern Louisiana in seed rice. In habit of growth and general appearance it is so similar to the cultivated rices that it is not easily distinguished from them until after it has flowered and begun to set seed. Its drooping and open panicles, which are not characteristic of any of the varieties grown in this section, are then distinctive.

Red rice germinates more readily at low temperatures and will grow under more adverse conditions than any of the white or cultivated rices. These latter varieties when sown in March and early

April are at a disadvantage in competition with this weed. On account of its quick germination at comparatively low temperatures, red rice makes a good growth before the cultivated varieties have emerged. If the sown stand is not completely destroyed, the surviving plants produce only a very small yield. A 25 per cent production of white rice is not unusual in a field that is badly infested with red rice.

The presence of red rice also affects the quality of the white rice. Rough rice containing red rice is graded very low for milling purposes, and the price is materially reduced. Rough rice containing red rice should never be used for seed.

The persistency of red rice as a weed is due very largely to the shattering of approximately 60 per cent of its seed by maturity. Without prompt and continuous control measures, this weed may take possession of a field within three seasons. The viability of the red-rice seed further complicates the control problem. This seed may remain in the ground in a viable state for several years and will germinate only when it is brought near the surface by plowing and other tillage operations.

On many farms in southwestern Louisiana where there is a heavy infestation of red rice and other weeds, a part of the acreage usually is left uncultivated and pastured for the purpose of cleaning the land. This method is not effective, because the number of available cattle is seldom large enough to keep down weed growth. In addition, there is always a quantity of seed of red rice lying too deeply in the soil to germinate until the land is again prepared for sowing the rice crop.

In the early winter of 1910–11 one-fourth of an acre of land was plowed on the Rice Experiment Station to determine the viability of self-sown red-rice seed. The land was so foul with red rice in the season of 1910 that it made only a 10 per cent production of white rice. This plat was disked and harrowed the following spring until a good seed bed was obtained. Seed, however, was not sown upon it. A perfect stand of red rice was obtained. This growth was mowed when the plants were from 6 to 8 inches high and often enough thereafter to keep the plants from flowering and setting seed. The land remained in sod for four years and was mowed each year during the growing season as often as was necessary to prevent growth and seed production. In the winter of 1914–15 the land again was plowed and in the following spring was disked and harrowed. Again seed was not sown. The resulting stand of red rice was even and uniform and was equal to the stand usually obtained by broadcasting seed at the rate of 60 pounds per acre. Red rice, therefore, will remain in the ground for at least four years without losing its viability.

After the first year mowing had little effect on the control of red rice, because very few seeds of this weed germinated. The greater part of the growth on the plat consisted of other weeds. This growth would have furnished a certain amount of pasture, but was of such character that a large acreage of it would have been required to support a small number of cattle. On account of the small revenue that would be derived from pasturing a weedy rice field, this method of control is expensive and also ineffective in eradicating red rice.

Corn also has been grown in rotation with rice on some of the well-drained lands in an attempt to control red rice. The corn is usually grown in high ridges, and this practice makes this crop ineffective in controlling the red rice. In making the high ridges a large proporton of the red-rice seed is covered so deeply that it does not germinate or grow during the season that the corn is being cultivated. It remains viable, however, and germinates when later the land is prepared for rice. The last cultivation of the corn crop also is too early to kill all the weed growth of that same season. For this reason alone corn is less useful in a rotation with rice than a crop requiring cultivation until a later date. The Biloxi soybean meets this requirement effectively, for if weed seeds do germinate after the last cultivation is given to this crop the new growth will be killed by frost before seed is produced.

The effectiveness of continued clean cultivation in controlling red rice was determined at the Rice Experiment Station during the seasons of 1911 to 1915, inclusive, as a part of the general experiments on weed control. The land was as foul as that in the sod and mowing experiment already described. One-fourth of an acre of this land was plowed in the winter of 1910 and disked the following spring. Plowing in winter and disking in spring were repeated each year during the period of the experiment. Seed, however, was not sown. A perfect stand of red rice was obtained in the spring of 1911. Each plowing and disking brought a certain part of the red-rice seed to the surface, where it germinated and later was killed by disking. Eleven successive germinations of red-rice seed were obtained during 1911. In each of the three succeeding seasons the number of germinations was less. In the spring of 1915, which was the last season of the experiment, a stand of only 15 red-rice plants was obtained on the entire one-fourth acre plat. This method unquestionably is effective but is expensive in time and labor. The land is also unproductive, a loss properly charged to cost. In addition, the soil loses in physical condition and fertility. Although effective in actually eradicating the red rice, this method is not equal to the soybean rotation. Before seeding both the soybeans and the rice, thorough tillage must be included as an important part of the weed-control program; but tillage alone can not meet all requirements.

SUMMARY

The largest acreage of rice in the United States in one area is grown in southwestern Louisiana. Level prairies, clay soils underlain by an impervious subsoil, a large supply of cheap water for irrigation, and a subtropical climate have contributed to the success of rice culture in this area.

The rice fields of southwestern Louisiana should be plowed in late autumn or early winter to a depth of 5 to 7 inches. The weather conditions of November are very favorable for field work, on account of the comparatively small amount of precipitation during this month. Winter-plowed land must be kept free of surface water. Lack of winter drainage may necessitate a second plowing in the spring and require much labor to get even an average seed bed. The results of an experiment on varying the depth of plowing show that

greater yields were obtained from the deeper than from the more shallow plowing.

The average increase of 477 pounds of rice per acre obtained on a smooth seed bed shows that a rough seed bed is not suited for the seeding of rice.

The average yields obtained in the date-of-seeding experiments show that the best approximate date for sowing rice is May 14. Earlier seeding than this approximate date, especially on land that is foul with weeds, often results in a weedy crop.

Weedy fields should be lightly disked repeatedly until May 10, and later if necessary.

The largest average acre yield was obtained when seed was sown with a drill at the rate of 80 pounds per acre, although the yield from the 100-pound drilled seeding was practically the same. The largest average yields of rice were obtained from sowing at the depth of 1 inch.

Acid phosphate, sulphate of ammonia, nitrate of soda, and cotton-seed meal did not increase the yield of rice when applied alone, nor did acid phosphate when applied with other fertilizers.

Dried blood may be advantageously applied as a source of nitrogen for rice when a legume is not used to supply this plant food.

Sulphate of potash applied at the rate of 100 pounds per acre produced an increase in yield when used alone and with sulphate of ammonia.

Sedges, which often become troublesome weeds, are greatly reduced in number when lime is applied, and the yield of rice may be increased by the application of limited quantities of limestone at intervals of several years.

The best yields of rice obtained at the rice experiment station were secured not by the use of fertilizers but by growing the crop in rotation with the Biloxi soybean.

Soybeans should be sown in rows 4 feet apart at the rate of 30 pounds of seed per acre, and not earlier than the last week in May or later than June 15. The crop should be harvested after the leaves have fallen, but not until the pods will open readily when pressed between the fingers.

Pasturing weedy fields is not effective in controlling red rice. The soybean rotation not only produces the best yields of rice but also effectively controls red rice and other weeds. Thorough tillage before seeding both the soybeans and the rice is an important part of the weed-control program.

Good drainage, good tillage, and proper crop rotation make unnecessary the application of any commercial fertilizer to the Crowley silt loam at the present time.

The average yield obtained by submerging the land 15 days after the rice plants emerged was 720 pounds greater than that obtained by submerging 15 days later. With each successive later date of submergence there was further reduction in average yield.

A submergence of 8 inches probably is the greatest depth of water that is required for profitable yields of rice, while a depth of 6 or even 4 inches may be sufficient on very level land where low levees are used.

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